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Direct measurement of the actual loading regime applied on the residuum of transfemoral amputee: From gait laboratory to continuous ambulatory recording

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Although a recent study [(1)] revealed that 82% of transfemoral amputees used their prosthesis daily, subjects also reported frequent problems. These concerns ranged from tissue breakdown of the residuum to unsatisfactory performance of prosthetic components including knees, feet, sockets, shock absorbers and osseointegrated fixation systems.

A better understanding of the real-world loading is required to improve the design of these components and the clinical outcomes of the prosthesis. Real-world loading results of a wide variety of activities amputees perform each day. Understanding the frequency (i.e. number of cycles) and the magnitude of loads associated to these activities is essential.

Studies focusing on the cycling of components have typically used pedometers or accelerometers over an extended period of time. Studies focusing on the magnitude of the load have used gait laboratories with motion analysis and force plates to determine the kinetics of each joint of the prosthetic leg during walking. As presented in Figure 1 (Conventional approach), neither of these approaches provided the actual loading regime during daily activities of the amputees.

A novel association of transducer and wireless modem allows monitoring the load applied on the residuum, for instance, during common daily activities (e.g. ascending and descending slope and stairs)[(2,3)]. Furthermore, this transducer can be attached to a data logger and monitor not only the frequency but also the actual loading of the prosthesis during normal daily life, as presented in Figure 1 (Innovative approach). This provides a more accurate picture of the real-world loading and overall usage of the prosthetic leg.

The aims of this presentation are:

A. To describe the apparatus used to directly measure the loading regime (frequency and magnitude) during daily living activities of transfemoral amputees fitted with conventional socket or osseointegrated fixation system (Figure 2).
B. To propose a conceptual framework to analyze the forces and moments measured.

It is anticipated that this paper will provide useful clinical and engineering information to those facing the challenge of restoring ambulatory ability to lower limb amputees.

Figure 1: *The conventional and innovative approaches used to determine the loading regime on the residuum.*

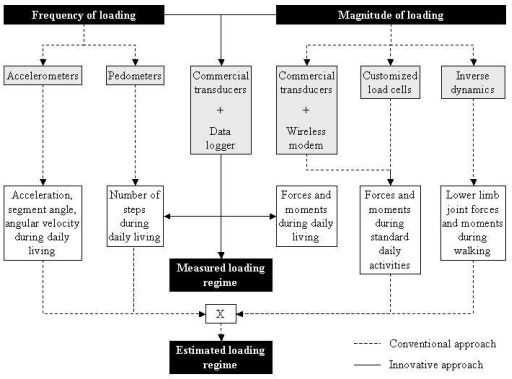
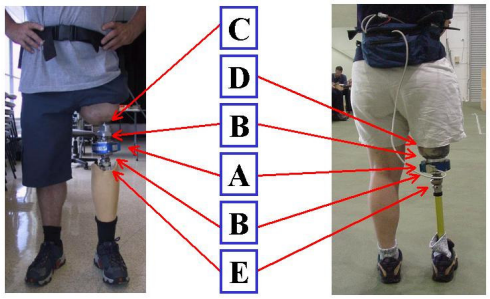


Figure 2: *Example of typical prosthetic leg used to directly measure the forces and moments applied on the residuum on transfemoral amputees fitted with an osseointegrated fixation system (left) or conventional socket (right). A commercial transducer (A) was mounted to specially designed plates (B) that were positioned between the abutment (C) or the socket (D) and the knee mechanism (E).*



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